

A revision of the Australian endemic genus *Pentalepis* (Asteraceae: Ecliptinae)

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Abstract

Orchard, A.E. & Cross, E.W. A revision of the Australian endemic genus *Pentalepis* (Asteraceae: Ecliptinae). *Nuytsia* 22(6): 371–392. The genus *Pentalepis* F.Muell., resurrected by Karis *et al.* in 1993, with two species, after being for many years included in *Moonia* Arn. or *Chrysogonum* L., has been studied morphologically across its full range. Four new species (*P. linearifolia* Orchard, *P. grandis* E.W.Cross, *P. kakaduensis* E.W.Cross and *P. walcottii* E.W.Cross) are described, as well as three subspecies in *P. trichodesmoides* F.Muell. (subsp. *trichodesmoides*, subsp. *hispida* Orchard and subsp. *incana* Orchard), two in *P. linearifolia* (subsp. *linearifolia* and subsp. *nudibranchioides* Orchard) and two in *P. ecliptoides* F.Muell. (subsp. *ecliptoides* and subsp. *hirsuta* Orchard), bringing the total to six species and eight subspecies. All taxa are keyed, described, illustrated and mapped.

Introduction

In 2004 the late Ed Cross commenced a revision of the Heliantheae Cass. alliance and the Eupatorieae Cass. for the *Flora of Australia*, beginning with Heliantheae subtribe Ecliptinae Less., especially the genera *Eclipta* L., *Wedelia* Jacq. and *Pentalepis* F.Muell. He had made good progress with several parts of this study, until his tragically early death in 2007 left the study incomplete. The present senior author was engaged by the Australian Biological Resources Study (ABRS) in 2010 to edit and complete the *Flora* manuscripts. This paper presents the results of that revision, in respect to the genus *Pentalepis*.

Mueller described *Pentalepis* partly on material collected at Nickol Bay, Western Australia, by Pemberton Walcott during the North-western Australia Gregory Expedition (1861), and partly on other material which he had collected himself in 1856 during the Northern Australia Gregory Expedition. Mueller simultaneously submitted his manuscript, describing the genus and two species, to the Botanical Society of Edinburgh and to the Edinburgh New Philosophical Society, and both organisations published it in 1863. John McNeill kindly examined holdings of the two journals at Edinburgh Botanic Gardens and was able to establish that the first version published was that by the Philosophical Society (Issue 11, dated April 1863, and probably published in April or May). The Botanical Society version was published towards the end of the same year, probably in November or December 1863, judging from the reports of Society Proceedings contained therein.

Bentham (1867) subsequently transferred *Pentalepis* and the two species to *Moonia* Arn. in *Flora Australiensis*. They were then transferred to *Chrysogonum* L. by Mueller (1882). Stuessy reduced both *Moonia* (Stuessy 1975) and *Chrysogonum* (Stuessy 1977) to monospecific genera from India and Ceylon (*Moonia*), and America (*Chrysogonum*), referring the Australian species to 'aff. *Blainvillea*'. In the *Flora of the Kimberley Region*, Lawrence (1992) recognised three Australian taxa (including both of Mueller's *Pentalepis* spp. plus an unnamed species) in *Chrysogonum*, while Karis *et al.* (1993) resurrected *Pentalepis*, with two named and one unnamed species. For the last 25 years *Pentalepis* has been accepted as an endemic northern Australian genus in the subtribe *Ecliptinae*, comprising two or three species. This study proposes that the genus is better described as six species and seven subspecies.

Materials and methods

This revision is based on morphological study of the holdings of *Pentalepis* specimens in the following herbaria: AD, BRI, CANB, DNA, HO, K, MEL, NE, NSW, NT and PERTH. Loans from most of these herbaria (excluding K and NSW) were obtained in 2004. Specimens in K were studied during a visit there in 2011, and a supplementary loan of recent collections (including duplicates from other herbaria) was obtained from DNA in late 2011. Some NSW specimens were studied during visits in 2010 and 2011. All illustrations were produced by the senior author, using a *camera lucida* to establish proportions and sizes.

Taxonomy

Pentalepis F.Muell., *Edinburgh New Philos. J. New Series* 17: 230 (Apr.–May 1863).

Pentalepis F.Muell., *Trans. Bot. Soc. Edinburgh* 7: 496 (Nov.–Dec. 1863), *isonym*.

Type: not designated. *Lecto*: *Pentalepis trichodesmoides* F.Muell., chosen by A. Cronquist (1964) according to Index Nominum Genericorum (ING) card 18249. Reference not traced. Also thus cited in published ING books.

Herbs or shrubs, erect, with variously hairy branches. *Leaves* opposite, sessile or shortly petiolate; *lamina* ovate-lanceolate, lanceolate, linear, rarely trifid or obovate, usually acute to acuminate, rarely blunt, entire or shortly toothed, usually 3-nerved, variously hairy. *Capitula* radiate, heterogamous, pedunculate. *Involucre*s narrowly to broadly campanulate; *bracts* 5, herbaceous, in 1 series, strigillose, each subtending a ray floret. *Receptacle* convex, with linear, strigillose, chaffy, persistent paleae. *Ray florets* 5, pistillate; corollas yellow; laminae 2-lobed; style branches linear, free. *Disc florets* functionally staminate; corollas yellow to orange, 5-lobed; *anthers* acute at base, with triangular apical appendages; *styles* fused, hairy, emerging from anther tube as a brush. *Ray achenes* black-brown, compressed, often cucullate; margins usually winged, with wing sometimes thickened and/or revolute; carpodium obscure; *disc achenes* narrowly linear, abortive. *Pappus* a minute cup, sometimes incised, strigillose, often with 2 short, soft, scale-like awns.

An Australian endemic genus, with six species in the Northern Territory and northern Western Australia.

Etymology. The generic name is from the Greek *penta* (five) and *lepis* (scale) referring to the single series of five bracts that make up the involucre. This is one of the characters distinguishing *Pentalepis* from relatives such as *Eclipta*, *Blainvillea* Cass. and *Wedelia*.

Notes. The involucre bracts are always five, each subtending a showy, long-ligulate ray floret, which is always pistillate. Other diagnostic characters are the narrowly linear (almost filiform), strigillose paleae, which subtend the disc florets and are retained on the receptacle long after the disc florets and ray achenes are shed, and the disc florets, which are functionally male, their style branches being fused into a single brush-like organ that becomes exserted from the anther tube. The achenes, all derived from ray florets, are strongly compressed, often cucullate, with weak keels on both surfaces (sometimes also with papillae on the adaxial surface), usually winged, the wings either membranous, spreading and marginally ciliate, or variously thickened, revolute, and minutely hairy. Wings are absent in the new species *P. walcottii* E.W.Cross, and in other species the wings often only develop fully right at maturity. The pappus is a shallow membranous cup, and the two awns, if present, are weak and scale-like. In the new species *P. kakaduensis* E.W.Cross and *P. walcottii* the pappus is virtually absent.

Key to species

- 1. Involucre bracts 7–12 mm long
 - 2. Shrub; capitula in crowded dichasial cymes **1. *P. trichodesmoides***
 - 2: Annual herb; capitula in open dichasial cymes **2. *P. grandis***
- 1: Involucre bracts 3–6 mm long
 - 3. Pappus cup-shaped, with 2 weak awns; disc florets (10–)16–30
 - 4. Leaves (linear–)lanceolate to broadly oblong or narrowly ovate, sometimes broadly trilobed, central lobe 5 mm or more wide **3. *P. ecliptoides***
 - 4: Leaves narrowly linear, (1.0–)1.5–2.0 mm wide **4. *P. linearifolia***
 - 3: Pappus cup-shaped, without awns, or pappus absent; disc florets 9–15
 - 5. Leaves trifid, with long basal lobes, central and basal lobes linear (rarely narrowly lanceolate), each 2–4 mm wide **5. *P. kakaduensis***
 - 5: Leaves ovate to lanceolate, coarsely toothed, lamina usually 15 mm or more wide **6. *P. walcottii***

1. *Pentalepis trichodesmoides* F.Muell., *Edinburgh New Philos. J. New Series* 17: 231 (Apr.–May 1863).

Moonia trichodesmoides (F.Muell.) Benth., *Fl. Austral.* 3: 540 (1867); *Chrysogonum trichodesmoides* (F.Muell.) F.Muell., *Syst. Census Austral. Pl.* 83 (1882). *Type citation*: ‘In vallibus rupestribus sinus Nickol Bay. *Walcott*’ (*holo*: rocky ravines at Nickol Bay, N.W. Coast of N. Australia, *s.dat.*, *Walcott s.n.*, MEL 1608228!; *iso*: Gregory Expedition, Nickol Bay, [*Walcott*], Herb. Hookerianum, K!).

Pentalepis trichodesmoides F.Muell., *Trans. Bot. Soc. Edinburgh* 7: 496 (Nov.–Dec. 1863), *isonym*.

Illustrations: M.E. Lawrence, in J.R. Wheeler (ed.), *Fl. Kimberley Region* 935, Figure 286K, 939, Figure 287G (1992) [as *Chrysogonum trichodesmoides*]; P.O. Karis, A.A. Anderberg & B. Nordenstam, *Austral. Syst. Bot.* 6: 151, Figure 1 (1993).

Shrubs, much branched, brittle, 0.4–1.0(–2.0) m tall; *young stems* glabrescent, with appressed hairs; *older stems* white, glabrous. *Leaves* very shortly petiolate, brittle; *laminae* linear, lanceolate, ovate or obovate, (25–)60–90 mm long, 10–35 mm wide, acute, acuminate or blunt, entire or with few inconspicuous teeth; both surfaces shiny and glabrescent, or hispid, or with white, dense, appressed hairs. *Capitula* 5–10 in a crowded dichasium on short peduncles; *involucre* narrowly campanulate, 10 mm long,

6–8 mm diam. *Disciflorets* c. 15; corollas yellow. *Achenes* broadly to narrowly ovate or slightly obovate, 5.5–7.5 mm long, 4.0–4.5 mm wide, weakly keeled, with broad, membranous, spreading, entire or lacerate wings when mature; *pappus* a shallow cup with 2 short, weak, scale-like awns.

Key to subspecies of *Pentalepis trichodesmoides*

Three subspecies can be distinguished.

1. Mature leaves shiny, smooth, with sparse short hairs on conspicuously swollen bases..... **1a. subsp. *trichodesmoides***
- 1: Mature leaves with dense white hairs, obscuring shiny surface and leaves thus appearing dull; hairs dense, with or without swollen bases
 2. Leaf lamina ovate to lanceolate, acute to acuminate; hairs 2-celled, (0.3–)0.5–0.7 mm long, separated by about their own length or slightly less, basal cell swollen **1b. subsp. *hispida***
 - 2: Leaf lamina obovate, blunt; hairs (2-)3- or 4-celled, 0.6–1.2 mm long, densely overlapping, all cells narrow..... **1c. subsp. *incana***

1a. *Pentalepis trichodesmoides* subsp. *trichodesmoides*

Shrub 0.5–1.0(–2.0) m tall. *Leaf lamina* mid- to dark green, lanceolate, 80–90 mm long, 10–20(–25) mm wide, acute to acuminate, both surfaces smooth, shiny, sparsely hispid; *hairs* white, 0.2–0.3 mm long, erect or curved, 1- or 2-celled, with basal cell conspicuously swollen, separated by (1–) several times their own length. Upper stems and involucral bracts with hairs as for leaves. *Achenes* ovate, 5.5–6.5 mm long, 4.0–4.5 mm wide; body grey-black, weakly keeled abaxially and adaxially, otherwise smooth apart from minute tubercles/hair bases, very shortly and sparsely hairy throughout or only apically; wing red-brown, membranous, spreading, entire or lacerate, with sparse, tiny hairs marginally. (Figures 1, 2A, B)

Selected specimens. WESTERN AUSTRALIA: Barrow Is., 17 Aug. 1973, *W.H. Butler* 2 (PERTH); Yathalla Well near Mt Rica, 22 Oct. 1941, *C.A. Gardner* 6387 (PERTH, 2 sheets); 5 miles [c. 8 km] NE Fossil Downs Stn, 5 Aug. 1959, *M. Lazarides* 6474 (BRI, CANB, K, MEL, NT, PERTH); Hammersley Range, 1 km N of Wittenoom, 4 Oct. 1989, *B. Nordenstam* & *A. Anderberg* 315 (K, MEL, PERTH); Camballin, May 1970, *Y. Power* 760 (PERTH); Dolphin Is., 5 June 1962, *R.D. Royce* 7197 (PERTH); Legendre Is., 9 June 1962, *R.D. Royce* 7286 (PERTH); King Leopold Ranges near track to Lennard River Gorge, 13 July 1988, *M.J.S. Sands* 5083 (DNA); Bungle Bungle, Mindjiyurrdi, 8 July 1984, *N.H. Scarlett* 302 (AD, CANB, DNA, PERTH); 42 km N of Hamersley HS, 31 Aug. 1995, *P.S. Short* 4288 (AD, CANB, MEL, PERTH); Meentheena Conservation Reserve, 25 May 2001, *S. van Leeuwen* 4802 (DNA, PERTH); Cycad Hill, Napier Range, 1 Sep. 1991, *P.G. Wilson* 874 & *R. Rowe* (DNA); W side of Oakover River, S of Woodie-Woodie, 5 Sep. 1991, *P.G. Wilson* 949 & *R. Rowe* (DNA). NORTHERN TERRITORY: 7 miles [c. 11 km] S Limbunya Stn, 10 July 1974, *R.A. Perry* 2340 & *M. Lazarides* (CANB, NT).

Phenology. Flowers collected in (May–)June–October(–December), fruits August–November(–December).

Distribution. Endemic to Western Australia (Hamersley and Kimberley Ranges, including off-shore islands), just extending into the Northern Territory, with one collection from near Limbunya Station (Figure 3A).

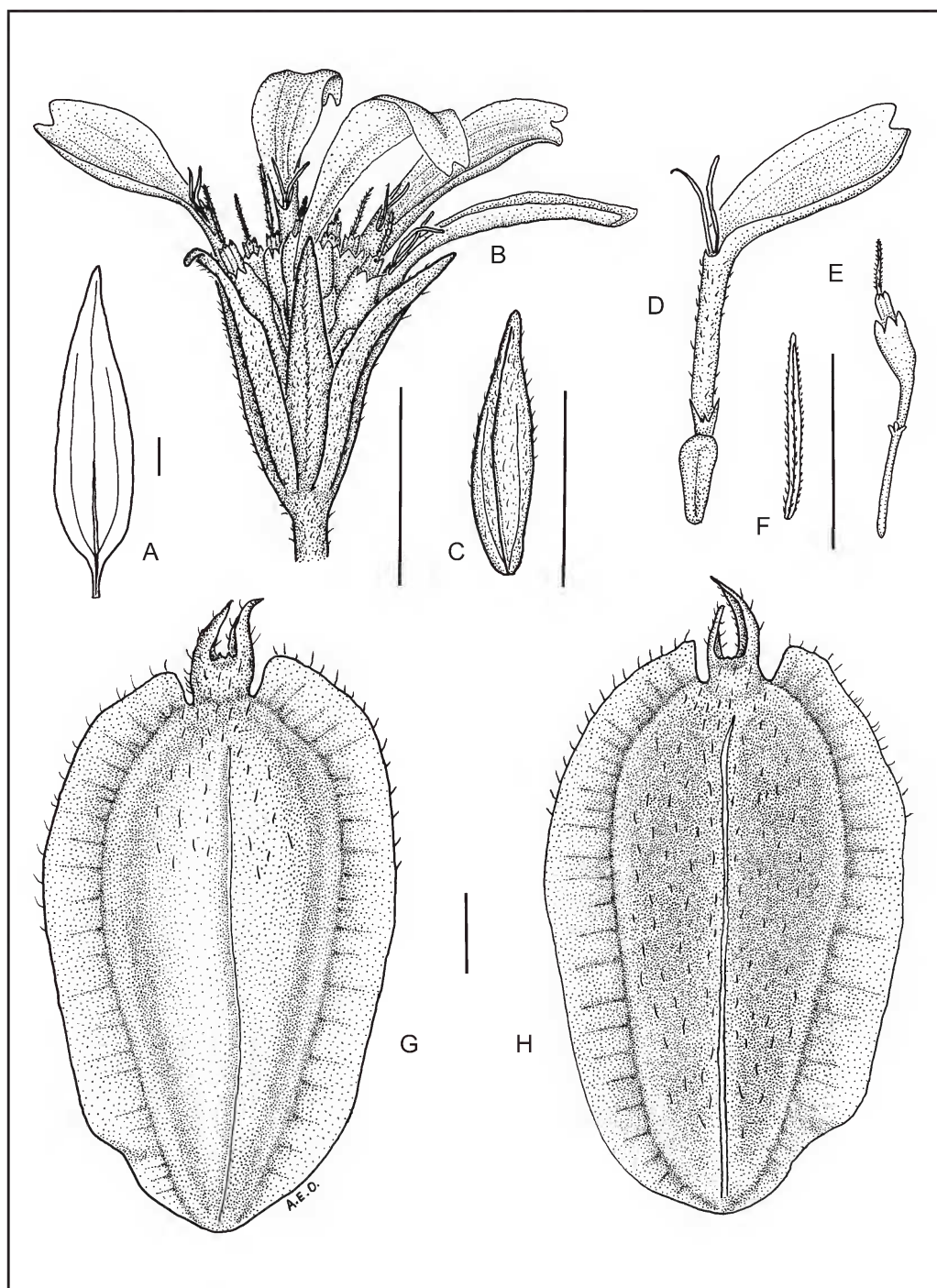


Figure 1. *Pentalepis trichodesmoides* subsp. *trichodesmoides*. A – leaf; B – capitulum; C – involucre bract; D – ray floret; E – disc floret; F – palea; G – achene, abaxial view; H – achene, adaxial view. All based on *P.S. Short* 4288, PERTH. Scale bars: A–E = 1 cm; G, H = 1 mm. © Commonwealth Government (Australian Biological Resources Study), reproduced with permission.

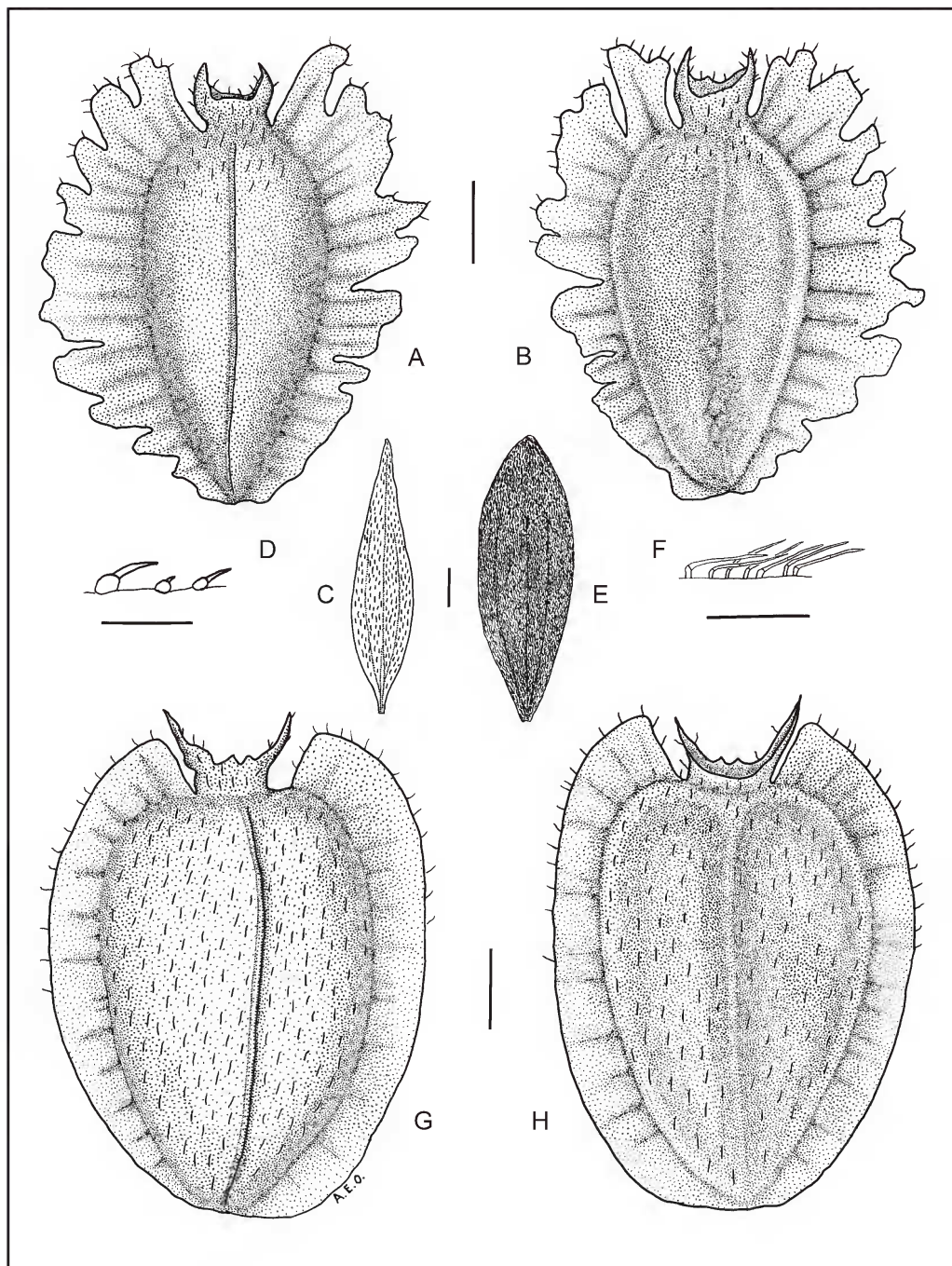


Figure 2. *Pentalepis trichodesmoides*. A, B – *P. trichodesmoides* subsp. *trichodesmoides*. A – achene with lacerate wings, abaxial view; B – achene, adaxial view; C, D – *P. trichodesmoides* subsp. *hispida*. C – leaf; D – leaf hairs; E–H – *P. trichodesmoides* subsp. *incana*. E – leaf; F – leaf hairs; G – achene, abaxial view; H – achene, adaxial view. A, B based on *N.H.Scarlett* 302, MEL; C, D based on *A.A.Mitchell* 3757B, PERTH; E–H based on *R.A.Perry* 2409, CANB. Scale bars A, B, D, F–H = 1 mm; C, E = 1 cm. © Commonwealth Government (Australian Biological Resources Study), reproduced with permission.

Habitat. Found in open situations in spinifex (*Triodia*) hummock grassland sandplains, on limestone and dolomite outcrops, and in stony watercourses, to altitudes of at least 300 m. Reportedly common after fire in limestone country.

Conservation status. Widespread and not at risk.

Notes. The type specimen of *P. trichodesmoides* in K has been incorrectly labelled as the holotype by Stuessy, 1973. It is an isotype. The holotype is in Mueller's own herbarium in MEL.

1b. *Pentalepis trichodesmoides* subsp. *hispida* Orchard, *subsp. nov.*

Type: east of Yalleen Homestead along railway line to Wickham, Western Australia [precise locality withheld for conservation purposes], 20 September 1994, *A.A. Mitchell* 3757B (*holo:* PERTH4069749!; *iso:* MEL 262445!).

Shrubs 0.4–1.0 m tall. *Leaves* dull green; *laminae* ovate to lanceolate, (25–)60–75 mm long, (10–)15–25 mm wide, acute to acuminate, both surfaces almost entirely covered with swollen hair bases; *hairs* white, (0.3–)0.5–0.7 mm long, ± appressed, 2-celled, with basal cell conspicuously swollen, with hairs separated by *c.* their own length or less. Upper stems and involucre bracts with hairs as for leaves. Mature *achenes* not seen. (Figures 2C, D)

Other specimens seen. WESTERN AUSTRALIA [localities withheld for conservation purposes]: 24 Apr. 1971, *K.H.L. Key s.n.* (CANB); 26 Sep. 1990, *E. Leyland* MC141 (PERTH); July–Aug. 1958, *P. McMillan s.n.* (PERTH); 22 Aug. 1995, *S. van Leeuwen* 1950 (DNA); 6 Aug. 1998, *S. van Leeuwen* 3628 (CANB, PERTH).

Phenology. Flowers recorded August and September, old fruiting heads (achenes dispersed) present August–April.

Distribution. Endemic to Western Australia, in the Tom Price–Millstream area of the Hamersley Range (Figure 3B).

Habitat. Found in *Triodia* hummock grassland, often in the understorey of a shrubland of *Acacia* spp., *Gossypium* spp., *Senna* spp., *Brachychiton* spp. and *Eucalyptus* spp., on summits and slopes of low hills, on basaltic soils, at altitudes to 1150 m.

Etymology. From the Latin for coarsely hairy: the leaves are conspicuously hispid as compared with subsp. *trichodesmoides*.

Conservation status. This taxon is restricted in distribution, but with some populations in National Parks. To be listed as Priority Two under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (K. Atkins pers. comm.). Equivalent to IUCN (2001) Data Deficient.

Notes. One collection of subsp. *hispida* (*K.H.L. Key s.n.*) is noted (*in sched.*) as the food plant of a new genus of grasshopper.

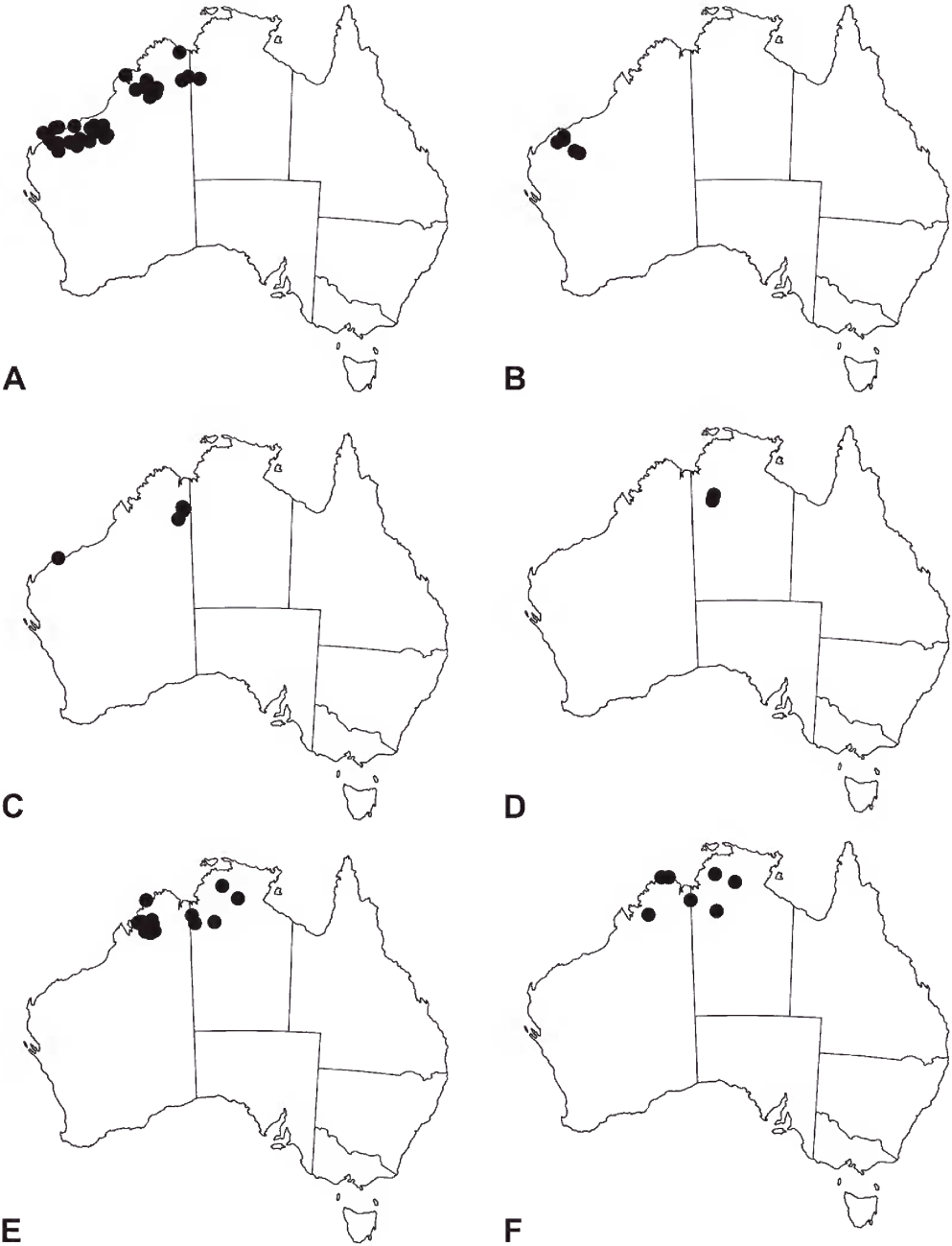


Figure 3. Distribution of A – *Pentalepis trichodesmoides* subsp. *trichodesmoides*; B – *P. trichodesmoides* subsp. *hispida*; C – *P. trichodesmoides* subsp. *incana*; D – *P. grandis*; E – *P. ecliptoides* subsp. *ecliptoides*; and F – *P. ecliptoides* subsp. *hirsuta*.

1c. *Pentalepis trichodesmoides* subsp. *incana* Orchard, *subsp. nov.*

Type: north-west of Turner River Station, Western Australia [precise locality withheld for conservation purposes], 10 July 1949, *R.A. Perry* 2409 (*holo*: CANB 588197!; *iso*: MEL 1609799!, NT 19076!, PERTH 431044!, PERTH 430730 *n.v.*).

Wedelia sp. A, *sensu* A.J.G. Wilson, in J.R. Wheeler (ed.), *Fl. Kimberley Region* 961 (1992).

Shrub 0.6–1.0 m tall. *Leaf laminas* silvery grey on both surfaces because of dense indumentum, obovate, upper leaves becoming narrower, 75–90 mm long, 25–35 mm wide, blunt; *hairs* white, 0.6–1.2 mm long, appressed, densely crowded and overlapping, (2-)3- or 4-celled, all cells narrow, tapering to tip. Upper stems and involucral bracts green with moderately dense indumentum as for leaves. *Achenes* ovate to slightly obovate, 6 mm long, 4.5 mm wide; body grey-black, keeled abaxially, weakly keeled adaxially, very shortly pilose throughout on both surfaces; wing yellow-brown, membranous, spreading, entire, shortly ciliate on distal margins. (Figures 2E–H)

Other specimens seen. WESTERNAUSTRALIA [localities withheld for conservation purposes]: 1898, *W.H. Cusack* 37 (MEL); 3 May 1999, *D.J. Edinger* 1307 (PERTH); 29 May 1975, *P. Ollerenshaw* 1667 (CANB, PERTH).

Phenology. Flowering in May, fruiting in July.

Distribution. Endemic to Western Australia, in the Albert Edward Range–Bungle Bungle region, with one old outlying collection (?mislabelled) from Nickol Bay (Figure 3C).

Habitat. Found in *Triodia* grassland and *Eucalyptus* woodland on skeletal soils on volcanic rock types.

Etymology. From the Latin for hoary: the leaves are densely appressed-hairy, giving them a silvery white appearance.

Conservation status. This taxon is restricted in distribution and is not known to occur within the conservation estate. To be listed as Priority One under DEC Conservation Codes for Western Australian Flora (K. Atkins pers. comm.). Equivalent to IUCN (2001) Data Deficient.

Notes. A very distinctive subspecies, notable in having leaves that differ from the other subspecies not only in shape, but also in their dense indumentum of long hairs, which makes them appear silvery. The specimen on which Wilson based her '*Wedelia* sp. A' in the *Flora of the Kimberley Region* has not been located. However, the description and the location (Bungle Bungles, from which almost no other wedelioid species are known) suggest that her plant was *P. trichodesmoides* subsp. *incana*.

2. *Pentalepis grandis* E.W.Cross, *sp. nov.*

Type: near Kalkarindji border, Wave Hill Station, Northern Territory, 20 March 1997, *C.R. Michell* & *C.P. Mangion* 678 (*holo*: DNA 132807!; *iso*: CANB 695823!).

Herbs, erect, rigid, annual, (0.2–)0.5–1.0 m tall; *stems* slender, scabrous with appressed hairs. *Leaves*

sessile, stiff; *laminae* ovate, 30–90 mm long, 7–26 mm wide, acute, regularly shortly toothed; both surfaces shortly strigose; *hairs* 0.3 mm long, appressed, with basal cell swollen and seated on a cluster of small epidermal cells, terminal cell conical. *Capitula* several in an open dichasium on elongated peduncles to 45 mm long; *involucre* hemispherical, 6–7 mm long, 6–9 mm diam. *Disc florets* 14–20; corollas yellow. *Achenes* oblong to obovate, 5–6 mm long, 2–3 mm wide, dark brown to black; abaxial surface smooth, convex, with dense, short, white hairs apically; adaxial surface concave, with central papillae and sparse short hairs; margins winged, with wings \pm thickened and revolute, shortly pilose; *pappus* a shallow cup with 2 short, weak, scale-like awns. (Figure 4A–H)

Other specimens seen. NORTHERN TERRITORY [localities withheld for conservation purposes]: 3 May 2003, J.A. Risler 2212 (DNA); 5 May 2003, J.A. Risler 2210 (DNA).

Phenology. Flowers and fruit recorded in March and May.

Distribution. Endemic to the Northern Territory from near the type locality, west and north-north-west of Wave Hill Homestead (Figure 3D).

Habitat. Found on brown clay or in black soil with scattered *Terminalia arostrata* and *Bauhinia cunninghamii*.

Etymology. From the Latin for large: of the herbaceous species of *Pentalepis* this is the most robust, equalled in size only by the shrubby *P. trichodesmoides*.

Conservation status. This species is restricted in distribution and no populations are known from National Parks or other conservation areas. IUCN (2001): Data Deficient.

3. *Pentalepis ecliptoides* F.Muell., *Edinburgh New Philos. J. New Series* 17: 231 (Apr.–May 1863).

Moonia ecliptoides (F.Muell.) Benth., *Fl. Austral.* 3: 540 (1867). *Chrysogonum ecliptoides* (F.Muell.) F.Muell., *Syst. Census Austral. Pl.* 83 (1882). *Type citation:* ‘In planitiebus virginem fluvii Victoriae versus (28th March 1856) [F.Mueller]’ (*holo:* Upper Victoria River, Trapp planis, 28 March 1856, F.Mueller s.n. [Gregory Northern Australia Expedition], MEL 1608229!).

Pentalepis ecliptoides F.Muell., *Trans. Bot. Soc. Edinburgh* 7: 496 (Nov.–Dec. 1863), *isonym*.

Herbs, erect or procumbent, annual, 0.2–0.6(–1.0) m tall; *stems* slender, covered with appressed hairs. *Leaves* sessile, stiff; *laminae* broadly linear to lanceolate, broadly oblong or narrowly ovate, rarely trilobed, 20–35(–70) mm long, 5–10 mm wide, acute, entire or minutely and irregularly toothed, sparsely scabrous to densely hirsute on both surfaces. *Capitula* several in loose dichasia, on elongated peduncles; *involucre* campanulate, 4 mm long, 5 mm diam. *Disc florets* 10–25; corollas yellow. *Achenes* oblong to obovate, 3.0–4.5 mm long, 3.0–3.5 mm wide; body dark grey to black or brown; abaxial surface convex and partly covered with minute white hairs; adaxial surface concave, often with central papillae, shortly pilose; wings thickened and revolute, sometimes with apex membranous and spreading; *pappus* a shallow cup with 2 short, weak, scale-like awns.

Endemic to northern Australia, in Western Australia and the Northern Territory. A very variable taxon with several local variants, differing in leaf shape, indumentum and achene shape.

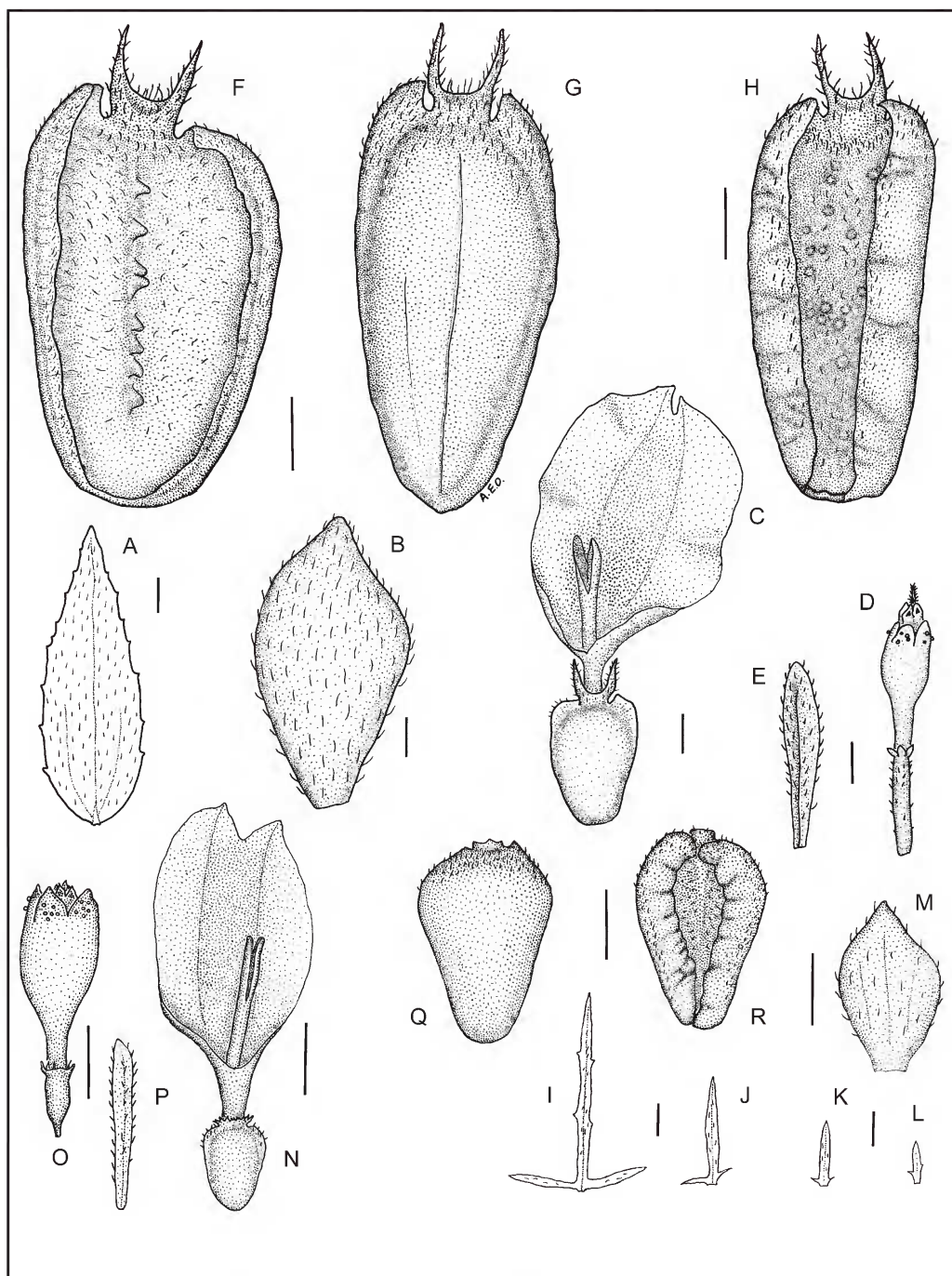


Figure 4. *Pentalepis* spp. A–H – *P. grandis*. A – leaf; B – involucre bract; C – ray floret; D – disc floret; E – palea; F – immature achene, adaxial view; G – mature achene, abaxial view; H – mature achene, adaxial view. I–R – *P. kakaduensis*. I–L – leaves, basal to upper; M – involucre bract; N – ray floret; O – disc floret; P – palea; Q – achene, abaxial view; R – achene, adaxial view. A–H based on *C.R. Michell* & *C.P. Mangion* 678, DNA; I–R based on *I.D. Cowie* 576, DNA. Scale bars: A, I–L = 1 cm; B–H, M–R = 1 mm. © Commonwealth Government (Australian Biological Resources Study), reproduced with permission.

Key to subspecies of *Pentalepis ecliptoides*

Three subspecies can be recognised.

1. Leaves, stems and involucre bracts shortly and moderately scabrous; leaves all linear-lanceolate to broadly oblong or narrowly ovate, never trilobed, entire or with only 1 or 2 tiny teeth
 2. Mature achenes with wing membranous and spreading at apex, thickened and revolute towards base.....**3a. subsp. *ecliptoides***
 - 2: Mature achenes with wing thickened and revolute throughout, the apical corners of the thickened wing revolute and ±touching on adaxial side of achene **3c. subsp. *cucullata***
- 1: Leaves, stems and involucre bracts long and densely hispid; leaves broadly linear to linear-lanceolate, often with some basal and mid-stem leaves broadly trilobed..... **3b. subsp. *hirsuta***

3a. *Pentalepis ecliptoides* subsp. *ecliptoides*

Chrysogonum sp. A, *sensu* M.E. Lawrence, in J.R. Wheeler (ed.), *Fl. Kimberley Region* 940 (1992).

[*Pentalepis* sp., *sensu* P.O. Karis, A.A. Anderberg & B. Nordenstam, *Austral. Syst. Bot.* 6: 153 (1993), *p.p.*].

Illustrations: M.E. Lawrence, in J.R. Wheeler (ed.), *Fl. Kimberley Region* 935, Figure 286J, 286L (1992).

Herbs, procumbent, 0.3–0.6(–1.0) m tall. *Leaf laminas* linear-lanceolate, lanceolate or narrowly ovate, 30–35(–70) mm long, 8–10 mm wide, entire or minutely and irregularly toothed, sparsely to moderately scabrous; *hairs* 0.3–0.4 mm long, white, 2-celled, with basal cell conspicuously swollen, seated on a rosette of tiny epidermal cells, apical cell narrower, tapering. Stems and involucre bracts with hairs as for leaves. *Achenes* obovate, 3.0–4.5 mm long; body dark grey; marginal wings thickened, revolute, often crenulate, the apex usually membranous, spreading and marginally ciliate; abaxial surface convex, smooth, weakly keeled, apically shortly hairy and often minutely tuberculate; adaxial surface tuberculate or papillose, with a weak keel. Figure 5D–H

Selected specimens. WESTERN AUSTRALIA: 10 km W of Mt Broome on the Milliewindie [Millie Windie] Track, 22 May 1988, *P.G. Wilson* 291 & *S.W.L. Jacobs* (BRI, DNA, PERTH); 5 km along Mt House Rd from Derby–Gibb River Rd, 19 June 1978, *A.S. George* 15154 (CANB, BRI, MEL, PERTH); 15 km N of Mt Disaster, 2 Mar. 1989, *G.J. Keighery* 10380 (PERTH); Bold Bluff area, King Leopold Ranges, 26 May 1971, *J. Maconochie* 1205 (BRI, NT); Bigge Is., 16 May 2003, *A.N. Start* 1587 (DNA); c. 5 km N of Mt House HS, 23 May 1967, *E.N.S. Jackson* 944 (AD); 30 km on Milliewindie [Millie Windie] Rd from Gibb River Rd, 19 Apr. 1988, *B.K. Simon s.n.* (BRI, CANB, DNA, PERTH); Camden Harbour, *s. dat.*, *F. Mueller s.n.* (MEL); Millie Windie Track, c. 17 km from Gibb River Rd, 29 Apr. 1988, [*M.J.S. Sands* 4641 (K, PERTH)]. NORTHERN TERRITORY: 8 miles [c. 13 km] S of Willeroo Outstation, 2 July 1949, *R.A. Perry* 2318 & *M. Lazarides* (AD, BRI, CANB, MEL, NT, PERTH); Cave Creek Stn, 20 Mar. 2003, *R.K. Harwood* 1259, (DNA); Cave Creek Stn, 3 May 2003, *J.A. Risler* 2213 (DNA).

Phenology. Flowers and fruits present March–July.

Distribution. Endemic to Western Australia and the Northern Territory from the west Kimberley in Western Australia, to the central part of the Top End of the Northern Territory (Figure 3E).

Habitat. Found on loam or clay loam soils in grassland and open *Corymbia* spp., *Eucalyptus* spp. and *Terminalia* woodland, on a range of substrates (basalt, granite, sandstone), at altitudes to at least 270 m.

Conservation status. Widespread and not at risk.

Notes. Lawrence's (1992) '*Chrysopogon* sp. A' was based on a specimen (T.E.H. Aplin *et al.* 1033, Lennard River Gorge, PERTH) which is one of very few specimens of this taxon with fully mature achenes. It is a good match with Mueller's type specimen. Karis *et al.* (1993) accepted Lawrence's taxon as a new (but still unnamed) species of *Pentalepis*. The specimens they cited under this tentatively recognised taxon included elements (Willis *s.n.*, Bradshaw & Allen *s.n.* and Fryxell & Craven 4182) now referred to *P. walcottii*, as well as others that belong here in *P. ecliptoides* subsp. *ecliptoides*.

3b. *Pentalepis ecliptoides* subsp. *hirsuta* Orchard, *subsp. nov.*

Type: west of Mount Muriel, Tipperary, Northern Territory [precise locality withheld for conservation purposes], 16 March 1989, Russell-Smith 7957 & Brock (*holo:* CANB 558442!; *iso:* AD 99027053!).

Pentalepis sp. Mt House (E.M. Bennett 1877), Western Australian Herbarium, in FloraBase <http://florabase.dec.wa.gov.au> [accessed 29 August 2012], based on PERTH 524891 (photo!).

Herbs, procumbent, 0.2–0.4 m tall. *Leaf laminas* broadly linear to linear-lanceolate, 20–25 mm long, 5–6 mm wide, entire or with occasional tiny teeth, basal and mid-stem leaves sometimes with large lateral lobes (i.e. broadly trilobed), densely hirsute; *hairs* white, 0.5–0.7 mm long, semiappressed, 2-celled, with basal cell distinctly swollen, seated on a rosette of tiny epidermal cells, apical cell narrower, tapering. Stems and involucre bracts with hairs as for the leaves. *Achenes* oblong to obovate, 3.5–3.7 mm long; body dark grey; marginal wings thickened and revolute throughout with apices not touching on adaxial surface, often crenate, shortly ciliate; abaxial surface convex, smooth, apically shortly pilose; adaxial surface concave, weakly keeled, usually with small tubercles. (Figure 5I–O)

Other specimens seen. WESTERN AUSTRALIA [localities withheld for conservation purposes]: 22 May 1967, N. Byrnes 346 (NT); 24 Aug. 2001, G. Krygsman 2 (DNA); 30 Mar. 1993, A.A. Mitchell 2984 (PERTH); 30 June 1973, P.G. Wilson 11194 (PERTH). NORTHERN TERRITORY: 25 May 1994, J.L. Egan 4141 (BRI, DNA); 21 May 1974, R. Pullen 9332 (CANB).

Phenology. Flowers noted March–August, fruit March–June.

Distribution. Endemic to Western Australia and the Northern Territory, at scattered localities from the Kimberley to western Arnhem Land (Figure 3F).

Habitat. In a range of soils (basalt, limestone, gravelly black soil, sandstone, sandy alluvium) in open shrubland, vine thickets and on creeksides.

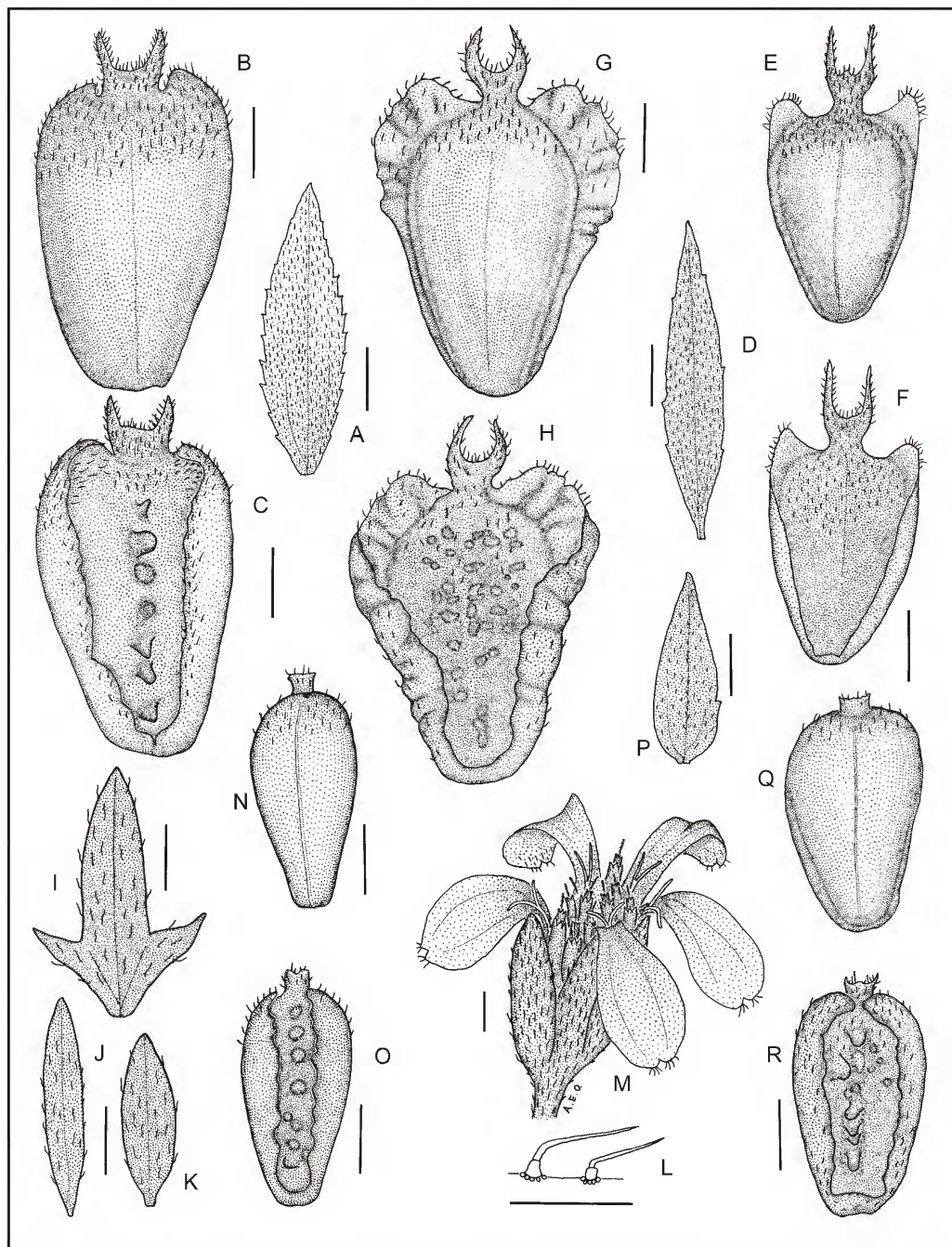


Figure 5. *Pentalepis eclipioides*. A–C Type specimen. A – leaf; B – achene, abaxial view; C – achene adaxial view. D–H *P. eclipioides* subsp. *eclipioides*. D – leaf; E – immature achene, abaxial view; F – immature achene, adaxial view; G – mature achene, abaxial view; H – mature achene, adaxial view. I–O *P. eclipioides* subsp. *hirsuta*. I–K – leaves; L – leaf hairs; M – capitulum; N – achene, abaxial view; O – achene, adaxial view. P–R *P. eclipioides* subsp. *cucullata*. P – leaf; Q – achene, abaxial view; R – achene, adaxial view. A–C based on *F. Mueller s.n.*, MEL; D–F based on *G.J. Keighery* 10380, PERTH; G, H based on *T.E.H. Aplin et al.* 1033, PERTH; I–O based on *A.A. Mitchell* 2984, PERTH; P–R based on *C.R. Mitchell & J. Risler* 1624, DNA. Scale bars: A, D, P = 1 cm; all others = 1 mm. © Commonwealth Government (Australian Biological Resources Study), reproduced with permission.

Etymology. From the Latin for bearing coarse erect hairs, referring to the densely hirsute leaves of this taxon as compared with the other subspecies.

Conservation status. Listed by Smith (2012) as Priority One under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora, as *Pentalepis* sp. Mt House (E.M. Bennett 1877). Also known from few localities in the Northern Territory (IUCN (2001): Data Deficient).

3c. *Pentalepis ecliptoides* subsp. *cucullata* Orchard, *subsp. nov.*

Type: Wollogorang Station, Northern Territory [precise locality withheld for conservation purposes], 8 July 1998, C.R. Michell & J. Risler 1624 (*holo*: DNA 135002!; *iso*: CANB!).

Herbs, procumbent, to 0.4 m tall. *Leaf laminae* lanceolate, 30–35 mm long, 8–10 mm wide, entire or with 1 or 2 tiny teeth, sparsely scabrid; *hairs* white, 0.3 mm long, semiappressed, 2-celled, with basal cell swollen, often seated on rosette of tiny epidermal cells, apical cell curved, claw-like. Stems and involucre bracts with hairs as for leaves. *Achenes* obovate, 3.3 mm long; body dark grey, cucullate; marginal wings thickened and revolute, touching at apex and base on adaxial side and forming a complete rim, minutely pilose; abaxial surface convex, minutely pilose apically, otherwise smooth and glabrous, with a weak central keel; adaxial surface sparsely and minutely pilose apically, with a central longitudinal row of large papillae. (Figure 5P–R)

Phenology. Flowering and fruiting in July.

Distribution. Endemic to the Northern Territory, and known only from the type locality on Wollogorang Station, at the extreme easterly extent of the species' distribution (Figure 6A).

Habitat. Common among boulders on sandstone scree-slope.

Etymology. From the Latin for hooded: the achenes are somewhat flattened with wings reflexed, the whole being concavo-convex (i.e. hooded).

Conservation status. This taxon is only known from the type collection, with apparently no populations in National Parks or other conservation areas and, as for all other than *P. trichodesmoides* and *P. grandis*, is a small rather inconspicuous plant almost certainly overlooked by collectors. Further fieldwork is required before finalising a determination of conservation status for this taxon. IUCN (2001): Data Deficient.

4. *Pentalepis linearifolia* Orchard, *sp. nov.*

Type: track to Surveyors Falls from Mitchell Plateau, Western Australia, 22 April 1977, A.S. George 14488 (*holo*: CANB 498309!; *iso*: K!, MEL 262462!, PERTH 418048 *n.v.*).

Herbs, erect, branching, annual 0.2–0.6(–1.4) m tall; *stems* slender, with moderately dense appressed hairs. *Leaves* sessile, stiff; *laminae* narrowly linear, (20–)40–50 mm long, (1.0–)1.5–2.0 mm wide, blunt, entire; both surfaces moderately densely appressed hairy; *hairs* white, 0.5–0.8 mm long, 2-celled, with basal cell thickened, often seated on rosette of tiny epidermal cells, apical cell narrower, tapering. Stems and involucre bracts with hairs as for leaves. *Capitula* several in lax, open dichasial



Figure 6. Distribution of A – *Pentalepis ecliptoides* subsp. *cucullata*; B – *P. linearifolia* subsp. *linearifolia*; C – *P. linearifolia* subsp. *nudibranchoides*; D – *P. kakaduensis*; and E – *P. walcottii*.

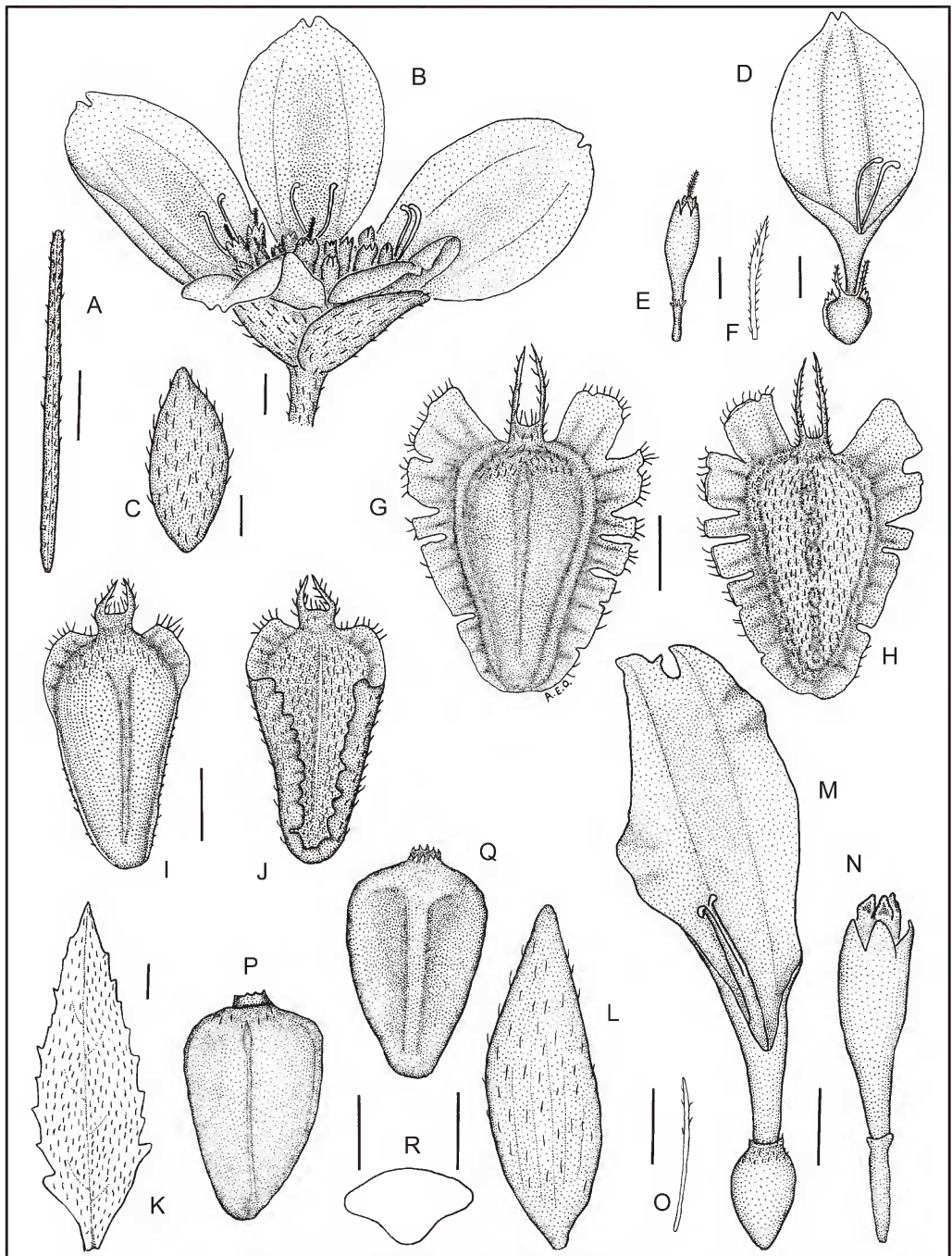


Figure 7. *Pentalepis* spp. A–H *P. linearifolia* subsp. *linearifolia*. A – leaf; B – capitulum; C – involucre bract; D – ray floret; E – disc floret; F – palea; G – achene, abaxial view; H – achene, adaxial view. I, J *P. linearifolia* subsp. *nudibranchioides*. I – achene, abaxial view; J – achene, adaxial view. K–R *P. walcottii*. K – leaf; L – involucre bract; M – ray floret; N – disc floret; O – palea; P – achene, abaxial view; Q – achene, adaxial view; R – transverse section of achene. A–H based on A.S. George 14488, CANB; I & J based on I.D. Cowie 4287 & L. Craven, PERTH; K–R based on J.H. Willis s.n., DNA (isotype). Scale bars: A, K = 1 cm; all others = 1 mm. © Commonwealth Government (Australian Biological Resources Study), reproduced with permission.

inflorescence, on slender peduncles 40–50 mm long; *involucre* obconical, 5 mm long, 5 mm diam. *Disc florets* 20–22; corollas yellow (?rarely orange). *Achenes* obovate, 3.5–4.0 mm long, 2.0–3.0 mm wide, weakly keeled, with a spreading membranous wing throughout or only apically (and then wing thickened and revolute basally); *pappus* a shallow cup with 2 short, weak, awns.

Occurs in Western Australia in the northern Kimberley, with occasional outliers in the Northern Territory near Katherine/Mataranka.

Key to subspecies of *Pentalepis linearifolia*

Two subspecies are recognised.

1. Achenes with membranous spreading wings throughout, ciliate on margins at least apically, and frequently lacerate or interrupted..... **4a. subsp. linearifolia**
1. Achenes with wings spreading and membranous only apically, ciliate on margins throughout, basally with wings thickened, revolute and deeply crenate..... **4b. subsp. nudibranchoides**

4a. *Pentalepis linearifolia* subsp. linearifolia

Herbs, erect, slender, ephemeral, 0.2–0.6(–1.4) m tall. *Achenes* 3.5 mm long, 2.5 mm wide; body dark grey to black; wings reddish brown, membranous and spreading throughout, often lacerate or interrupted, ciliate on margins at least apically; abaxial surface convex, weakly longitudinally keeled, apically minutely pilose, otherwise glabrous; adaxial surface smooth, apart from weak longitudinal keel, minutely pilose throughout. (Figure 7A–H)

Other specimens seen. WESTERN AUSTRALIA [localities withheld for conservation purposes]: 23 Apr. 1977, Hj. Eichler 22454 (CANB, NSW); 10 May 1983, P.A. Fryxell & L.A. Craven 4016 (CANB, DNA, K, MEL, PERTH); 25 June 1976, K.F. Kenneally 5335 (CANB); 24 July 1976, J. Lewis 53 (CANB, PERTH).

Phenology. Flowering and fruiting (February–)March–July(–August).

Distribution. Endemic to Western Australia in the northern Kimberley, on the Mitchell Plateau and towards Port Warrender (Figure 6B).

Habitat. Found in herbfields and grassland, open woodlands and vine thickets, in gravelly soils, loams and laterites, often over basalt.

Etymology. From the Latin for linear-leaved.

Conservation status. This taxon is restricted in distribution and is not known to occur within the conservation estate. To be listed as Priority One under DEC Conservation Codes for Western Australian Flora (K. Atkins pers. comm.). Equivalent to IUCN (2001) Data Deficient.

Notes. Leaves in this subspecies are often brittle and sparse, and because of their narrowness the two lateral veins usually present in the leaves of *Pentalepis* are absent or obscure. Corollas are usually described as yellow, but in one case as ‘orange’.

4b. *Pentalepis linearifolia* subsp. *nudibranchoides* Orchard, *subsp. nov.*

Type: south of Kalumburu, Western Australia [precise locality withheld for conservation purposes], 26 May 1993, *I.D. Cowie* 4287 & *L. Craven* (*holo*: PERTH 5815282!; *iso*: CANB 479561!, DNA 71608!, MEL 1619327!).

Herbs, erect, annual, 0.3–0.6 (–1.0) m tall. *Achenes* 3.5–4.0 mm long, c. 1.7 mm wide; body dark grey; wings reddish brown to grey, narrow, membranous and spreading apically, thickened, revolute and deeply crenate basally, ciliate on margins throughout; abaxial surface convex, weakly longitudinally keeled, otherwise smooth, minutely pilose apically; adaxial surface weakly keeled, minutely tuberculate, minutely pilose throughout. (Figure 7I, J)

Other specimens seen. WESTERN AUSTRALIA [localities withheld for conservation purposes]: 30 Apr. 1985, *T.E.H. Aplin et al.* 836 (CANB, PERTH *n.v.*); 4 June 1976, *A.C. Beaughtole* 52057 (PERTH); 24 May 1993, *I.D. Cowie* 4258 & *C. Brubaker* (CANB, DNA, PERTH); 25 May 1975, *D.E. Symon* 10174 (AD, CANB, PERTH *n.v.*). NORTHERN TERRITORY: 29 Apr. 1947, *S.T. Blake* 17527 (AD, BRI).

Phenology. Flowering and fruiting April–May(–June).

Distribution. Endemic to the northern Kimberley, Western Australia, along the Carson River catchment, with one (possibly two) collections from the Katherine/Mataranka area in the Northern Territory (Figure 6C).

Habitat. Found on lateritic gravel soils, clay loam over dolerite and stony basalt, in *Eucalyptus* spp. woodland and grassland, at altitudes to at least 140 m.

Etymology. The epithet alludes to the resemblance between the achenes of this subspecies and some nudibranchs (sea-slugs).

Conservation status. This taxon is restricted in distribution and is not known to occur within the conservation estate. To be listed as Priority One under DEC Conservation Codes for Western Australian Flora (K. Atkins pers. comm.). Also poorly known in the Northern Territory (IUCN (2001): Data Deficient).

Notes. Only one definite record of this taxon (dated 1947) is known from the Northern Territory but a second, in flower only (Northmeat Farm, Katherine, 11 Apr. 1968, *C.S. Robinson* 47, DNA), probably represents this taxon.

5. *Pentalepis kakaduensis* E.W.Cross, *sp. nov.*

Type: Kakadu National Park, Northern Territory [precise locality withheld for conservation purposes], *I.D. Cowie* 576, 17 March 1987 (*holo*: DNA 59743! (mounted on 2 sheets)).

Herbs, erect, slender, branching, annual, 30–40 cm tall; *stems* sparsely appressed-hairy. *Leaves* sessile; laminas trifid, with central lobe greatly exceeding length of two basal, lateral lobes, giving the appearance of 3 simple leaves; lobes linear to narrowly lanceolate, 15–65 mm long, 2–4 mm wide, acute, entire or

with occasional small tooth; adaxial surface strigose, abaxial surface with hairs restricted to margins and midrib; *hairs* 0.2–0.3 mm long, 2-celled, appressed; basal cell swollen, seated on a cluster of tiny epidermal cells; apical cell conical. *Capitula* sparse, in an open, lax dichasial inflorescence, on slender peduncles to 35 mm long; *involucre* campanulate-hemispherical, 3 mm long, 3–5 mm diam. *Disc florets* 10–15; corollas yellow. *Achenes* obovate, 2.8–3 mm long, 1.7–2.0 mm wide, dark brown to black; abaxial surface convex with minute hairs apically, otherwise smooth; adaxial surface concave, centrally flat, with weak central keel, minutely pilose throughout, occasionally papillose; marginal wing thickened, revolute, usually crenate, often with apical points touching on adaxial surface. *Pappus* diminutive, or absent; if present minutely cup-shaped, lacking awns. (Figure 4I–R)

Other specimens seen. NORTHERN TERRITORY [localities withheld for conservation purposes]: 29 June 2007, K.G. Brennan 7328 (CANB, DNA); 25 Feb. 1988, C.R. Dunlop 7656 & P. Minchin (BRI, DNA).

Phenology. Flowers and fruits collected February and March

Distribution. Known only from three Northern Territory collections, two from Kapalga in Kakadu National Park, and one from Napier Peninsula (Figure 6D).

Habitat. In *Eucalyptus* woodland with shallow soils and lateritic gravel at surface.

Etymology. From the Latin *-ensis* (origin) and Kakadu: the species is largely confined to Kakadu National Park.

Conservation status. This taxon is restricted in distribution, but with some populations within a National Park. IUCN (2001): Data Deficient.

Notes. *Pentalepis kakaduensis*, with *P. walcottii*, differs from other *Pentalepis* taxa in having a reduced pappus cup and no awns. Because of its narrow leaves, the two lateral veins usually present in the leaves of *Pentalepis* are absent or obscure in this species.

6. *Pentalepis walcottii* E.W.Cross, *sp. nov.*

Type: North Kimberley, Vansittart Bay, Western Australia [precise locality withheld for conservation purposes], 26 May 1984, J.H. Willis *s.n.* (*holo:* PERTH 1656546!, *iso:* DNA 28761!, MEL 1152600!).

Pentalepis sp., *sensu* P.O. Karis, A.A. Anderberg & B. Nordenstam, *Austral. Syst. Bot.* 6: 153 (1993), *p.p.*

Herbs, erect, branched, annual, 0.4–1.0 m tall; *stems* slender, with appressed hairs. *Leaves* subsessile; laminas ovate to lanceolate (30–)50–100 mm long, (4–)15–25 mm wide, acute, regularly or irregularly coarsely toothed, sparsely to moderately densely hairy; *hairs* white, 0.3–0.5 mm long, 2-celled, appressed, with basal cell swollen, seated on a cluster or rosette of tiny epidermal cells, apical cell narrower, tapering. *Capitula* several in a lax, open dichasial inflorescence, on slender peduncles 4–50 mm long. *Involucre* campanulate, 5–6 mm long, 2–5 mm diam. *Disc florets* 9–15; corollas yellow. *Achenes* obovate, 2–3 mm long, 2 mm wide, dark grey; abaxial surface convex with prominent keel, glabrous or with very sparse short white hairs apically; adaxial surface concave, with a prominent keel, glabrous. *Pappus* a short cup with regularly placed inward-pointing hairs; awns absent. (Figure 7K–R)

Other specimens seen. WESTERNAUSTRALIA [localities withheld for conservation purposes]: 1891, [J.] Bradshaw & [W.T.] Allen s.n. (MEL); 6 June 1921, C.A. Gardner 854 & 1354 (PERTH); 13 May 1983, D. Dale 6 (PERTH); 15 May 1983, D. Edinger 42 (PERTH); 16 May 1983, P.A. Fryxell 4182 & L. Craven (CANB, MEL, PERTH); 19 May 1986, K.F. Kenneally 9717 (PERTH); 1 June 1992, K.F. Kenneally 11178 (DNA, PERTH); 24 Mar. 1993, A.A. Mitchell 2895 (PERTH); 4 Apr. 1991, T. Willing 313 (PERTH); 28 June 1973, P.G. Wilson 11071 & 11124 (PERTH).

Phenology. Flowers and fruits March–June.

Distribution. Endemic to Western Australia in the north-western Kimberley, from Walcott Inlet to Carson River, including a number of offshore islands (Figure 6E).

Habitat. Growing in sandy soils, on outcrops or gravel beds, on sandstone or basalt, often associated with creeks, rivers and bays.

Etymology. Named for Pemberton Walcott (1834–1883), plant collector on F.T. Gregory's expedition into north-western Australia in 1861, and collector of one of the species on which the genus was based.

Conservation status. This taxon is currently known from ten collections, mostly from remote locations, including areas at low risk. Further fieldwork is required before finalising a determination of conservation status for this taxon. To be listed as Priority Three under DEC Conservation Codes for Western Australian Flora (K. Atkins pers. comm.). Equivalent to IUCN (2001) Data Deficient.

Notes. The two lateral veins usually present in the leaves of *Pentalepis* are weak and obscure in this species. Instead, the leaves appear pinnate-veined. The plant is described as sticky on one specimen label (P.G. Wilson 11124).

Acknowledgements

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